WEALE'S

RUDIMENTARY

SERIES

HANDRAILING

ON HANDRAILING

A PRACTICAL TREATISE

ON

HANDRAILING

SHOWING

NEW AND SIMPLE METHODS FOR

FINDING THE PITCH OF THE PLANK,
DRAWING THE MOULDS, BEVELLING,
JOINTING-UP, AND SQUARING THE
WREATH

By GEORGE COLLINGS

Illustrated with Plates and Diagrams

Capio Lumen

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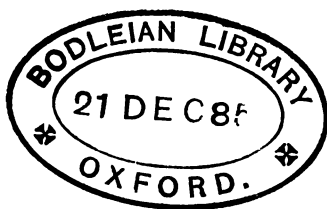
PREFACE.

THE Author of the following treatise having
been employed for several years as a practical
Handrailer, and having found great difficulty in
applying the methods given in the various works
which have been published on the subject, has
endeavoured to work out a practical method of his
own, which he now presents to his fellow-work-
men, with a hope that it may meet with their
acceptance, and be found of practical utility in the
execution of this difficult branch of Joinery.

In compiling this work, the Author has con-
sulted all the best authorities on the subject, and
examined every source from which help was
likely to be obtained. While therefore he does
not lay claim to be the inventor of the whole of
the system which is here given, for much of which
he is indebted to those who have preceded him,
he nevertheless believes that the simple method
of finding the direction of the major axis for
drawing the curves of the moulds has never been
introduced before, and will be found to be much
simpler as well as more practically useful than

the equivalent method of finding the *oblique plane*, *pitching plane*, or *plane of the plank*, of the other systems.   The method which he has introduced of drawing the curves is also considered to be much simpler than the old system of ordinates. The mould can be got out by the one method in every case without any variation.

Of course these eight Plates do not embrace all the different plans which may occur in practice, but they are representative of the majority of them ; and those who master this system will have no difficulty in applying it to any other cases with different arrangement of plan.

It is believed that this treatise will be found sufficiently complete ; the process of bevelling, jointing-up, and then squaring the *wreath* being fully explained, so as to leave nothing further to be desired except that all-important thing necessary to efficiency, namely, *practice*.

The Author has constantly applied this system himself in the practical execution of some of the best examples of Handrailing, and is therefore able to vouch for the correctness of the rules here laid down for getting out the moulds, by the results he has been able to obtain.

GEORGE COLLINGS.

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is moved, any number of such points in the curve
may be found.

2. Suppose, however, that instead of the dia-
meters, or axes, of the ellipse being given, we
have two points on the curve, as A and D, and also
the centre I and the length of the minor axis only
given, from which data it is required to determine
the length and direction of the major axis.   Then
the foregoing method of drawing an ellipse sug-
gests a ready way of doing this.   For instance,
provide a *square*, as H J K L (Fig. 1*b*), of any stiff
thin material, and at or near the middle of the
side J L, draw the line I G at right angles to J L.
Place this square with the point I to the given
centre I of the required ellipse (supposing of
course that the diameters and curve are not there),
and lay the line J L of the square as nearly as
possible in what is *supposed* to be the direction of
the required major axis.   Now apply A B, the
given half minor axis (on the slip Fig. 1*a*), from
the two given points A and D, making the points
B on the slip to lie upon the edge J L of the square
at B and E.   Prolong A B and D E from each point
to cut I G in C and F.   Then if A C and D F are
equal, J L is the direction of the major axis, and
A C or D F will be its half length.

If at the first trial it is found that A C and D F
are not equal, then move the edge J L of the

PLATE I.

Fig.1.

Fig.1.ᵇ

Fig.1.ᵃ

Fig 5

Fig.3.

Fig.4.

Fig.2.

square round until they become so, keeping ɪ to
the given centre of the ellipse, ʙ over ᴊ ʟ, and ᴀ
to the given points.

An ordinary rule, such as is used by joiners,
will serve the purpose of finding the direction and
length of the axes. And for a square, if for use
in a joiner's shop, nothing better can be had than
a wide piece of thin board with a line drawn in
the middle at right angles to one end.

We will suppose that Fig. 1 is drawn to a scale
of ¾-inch to a foot, when the major axis will measure
2 feet, and the minor axis 1 foot 4 inches, half of
which will be 12 inches and 8 inches respectively.
Lay down the centre and the two points ᴀ and ᴅ
at their relative distances from each other, full
size. Place the square with the end of the line
in the middle to the given centre, then apply a
rule from the points ᴀ and ᴅ, being careful to let
each point be in an exact line with the edge of
the rule. Lay the square so that 8˙ inches
measured from each point, as directed, shall be
exactly over the end ᴊ ʟ, and the rule will cut
the line in the middle at 12 inches from ᴀ
or ᴅ.

If then a line be drawn across the end ᴊ ʟ of
the square for the direction of the major axis,
and the curve described as before stated, it will
be found to pass through the two given points ᴀ

and D.   Thus when these two lines A C and D F,
drawn as directed, are found equal in length,
each will equal half the longer diameter or
major axis, and the end of the square will give its
direction.

   The method described above is the one we
propose to use for drawing the moulds throughout
this system of handrailing.   It is very simple,
sufficiently correct, and can be applied with very
little trouble.

   We shall explain hereafter how to find the
centre and the two points A and D, and we know
from the principles of geometry that the curve to
be drawn through the two points should be
elliptical, because they are in the circumference
of an oblique section of a circular cylinder.

   The length of half the minor axis for the
elliptic curve will always be equal to the radius
of the quarter or half circle over which the two
points are situated.

   3. Fig. 2 shows how to obtain the angle for
mitreing the rail into a newel cap.   The section
on the edge of the cap should be the same as
the rail to be mitred into it.   Draw a section
and plan of the rail, also draw the plan of
the circumference of the cap.   Then take the
greatest distance to which the moulding is
worked on the under or upper side of the rail, as

the case may be, and draw a line parallel to the edge at this distance.

Draw also at the same distance another circle concentric with the outer circumference of the cap. Then from the intersection of the outside of the rail with the outside of the cap, and through the point where the inner parallel lines meet, draw the mitre. This will be found as near an approximation as possible without having recourse to a circular mitre to get both rail and cap to look alike.

If the mitre is carried in further than this, as is sometimes the case, the section of the cap will have to be found on this mitre line, and while the vertical projections of the moulding will remain the same, the horizontal will be increased considerably, producing a thinner appearance altogether on the cap than what the rail has.

4. Fig. 3 shows a method of cutting the mitre in the cap by using a piece of scantling one side of which is planed true. Draw a line in the centre of the width, and on each side of it set off the distance 1, 2 (Fig. 2). Then make a cut with a saw to these last two lines, and mark the width of the rail on the extreme edge of the cap, which should then be fastened to the scantling by driving a screw through the centre line into the centre of the cap.

Place one of the marks denoting the outside of the rail opposite one of the cuts, and make a saw cut to the required depth. Then turn the cap round until the other outside of the rail is brought opposite the other cut, and make another saw cut to complete the mitre.

Another method is to use one cut only in the piece, and to drive the screw through at the bottom of this cut into the cap at the point where the mitres meet. This plan is perhaps the least troublesome. The only objection to it is that the mitre cannot be cut quite home either way until the cap is released from the block, owing to the screw being in the way of the saw.

5. Figs. 4 and 5 show a handy method of drawing a curtail scroll. In Fig. 5, which is a magnified representation of Fig. 4, the width A B is divided into eight equal parts. Make A D equal to one of these parts and at right angles to A B, and join B D. Place one foot of the compasses at C, the centre of A B, extending the other foot to touch the line B D, and draw the arc, cutting A B in the point 1. Then 1 is the centre of the first or largest quadrant of the scroll. Draw 1 E square to A B, and from 1 as a centre draw the large quadrant B B. Draw D 2 parallel to A B. The point 2 is then the second centre. In order to find the remaining centres, from E draw E F square

to B D. From 1, through the point where B D and E F cross each other, draw 1 3. From 3, draw 3 4, parallel to 1 E. Then draw 2 4, and from where 3 4 cuts this last, draw 4 5 parallel to A B, 5 6 parallel to 1 E, 6 7 parallel to 4 5, and so on until a sufficient number of centres are found from which to complete the scroll.

The advantage of this method of drawing a scroll is that the width A B may be varied to suit any width of rail. For a wide one it may be increased, and for a narrow one diminished. If another quadrant or part of a quadrant is required, it is only necessary to increase its radius in the same proportion as the first radius is to the second, and then set the foot of the compasses at this distance from B, on the line A B, as shown by the dotted lines on Fig. 4.

Several other methods of drawing scrolls or spirals will be found in a treatise on "Practical Geometry for the Architect, Engineer, Surveyor, and Mechanic," by E. Wyndham Tarn, Architect.*

* Crosby Lockwood and Co.

PLATE II.

6. This Plate presents a very simple case in continued handrailing. The lines necessary for this pair of wreaths might be obtained from the pitchboard. We think, however, that it will be better to leave the pitchboard alone for the present, and explain the method taught in the following pages as fully as possible in its application to this simple case, instead of leaving it until we come to a more complicated one.

Fig. 1 is the plan of a well-hole of a staircase, with straight flights above and below the landing. The rail is shown the whole width up to the springing line of the curved part; beyond that the centre only is laid down with the tangents to the half circle, 1, 2, 3, 4, 5, and the diagonal, 1 3. The riser lines, landing, and starting are not drawn to the centre of the circle: the distance from riser landing to 2, and from 4 to riser starting, is made equal to half the *going* or tread of one step. By this arrangement the rail has a

PLATE II.

Fig.1.

Fig.2.

Fig.3.

Fig.4.
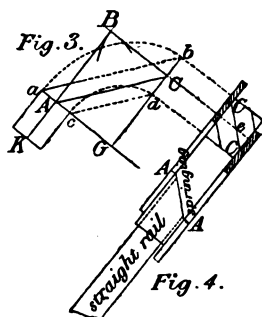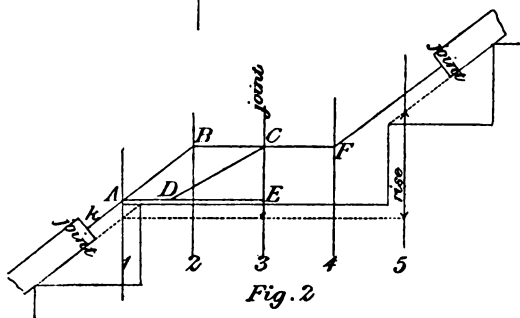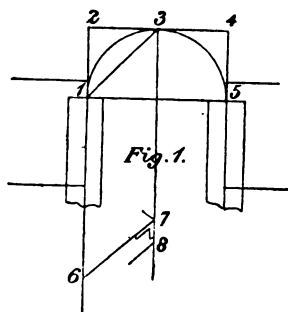
better appearance than when more of it is thrown on the level.

Fig. 2 is the development, or stretch-out in elevation, of the centre line and tangents of Fig. 1. Draw the landing with a step above and below, erect the perpendiculars to coincide with the points 1, 2, 3, 4, 5, of Fig 1. The distances from 1 to 2, from 2 to 3, and so on, will then be equal in each figure. Draw the under side of the rail resting on the angles of the flyers, and at the distance of half the thickness of the rail draw the centre line, and continue the upper one downwards to cut the vertical line 4 at F; continue the lower one upwards to cut the vertical line 2 at B, and draw the horizontal line B F. The centre joint at C will be vertical, owing to B F being level. Draw the upper and lower joints square to the centre line. From A, where the centre pitch cuts the vertical line 1, draw A E horizontal. From E set off E D equal to the diagonal 1 3 (Fig. 1). Draw D C, then this line will be the diagonal for the mould, and when placed to its proper pitch on the plan, will lie over 1 3 from end to end.

Fig. 3 shows the method of drawing the mould. Make A B (Fig. 3) equal to A B (Fig. 2), and draw B C at right angles to B A and equal to B C (Fig. 2). Then A C, the hypothenuse of the right-angled

triangle A B C, is equal to D C (Fig. 2).   Prolong
the line A B until the distance A K (Fig. 3) is
equal to the distance A k (Fig. 2).   Draw the
end of the mould square to A B; through A and
C draw A G and C G parallel to A B and B C; G
will then be the centre of the elliptic curves of
the mould.   The line B C being level, the
angle B will be square, the bottom end of the
mould will therefore be square, and the same
width as the rail.   Draw the width of the rail
parallel to A B.   To find the bevel and width for
the top end, take A B (Fig. 3) in the compasses,
and with one foot at any point 6 (Fig. 1) on
centre line of rail, draw the arc cutting the centre
line of well-hole at 7.   Draw 6 7, and this
gives the bevel.   Parallel to 6 7 set off half the
width of the rail, and 7 8 will be half the width
of the mould.   Repeat this distance on each side
of C (Fig. 3), and this gives the point to which we
have to draw the quarter-ellipses of the mould.
Or, a c being the width of the rail, the lines a b,
c d, drawn parallel to A C, will give b d its width at
the centre of the wreath; and G a, G b will be the
semi-axes of the ellipse for the outside of the rail,
G c and G d the semi-axes of the ellipse for the
inside.   B C being level, A G and C G will be the
directions of the diameters.   G is the centre
coinciding with the centre of the half circle in

Fig. 1. Therefore from G to the inside and outside of the mould on each diameter will be half the shorter and half the longer axes respectively. If now we mark off these distances from the end of a thin straight edge, and carry it round, keeping one of the points on each diameter (as shown by Plate I.), any number of points can be obtained through which the curves of the mould may be correctly drawn. Draw the lines A B and B C opposite each other on both sides of the mould, and square the springing A B across the inside edge. This will mark the termination of the straight part and the commencement of the circular, and will be made use of when the mould is applied to the plank. Both the half wreaths being alike, there is no necessity to get out a separate mould for the upper one.

Fig. 4 shows the application of this mould to the plank for the purpose of working it to the twist or *bevelling* (we shall throughout this work call it *bevelling*). The piece is first cut out square to the shape of the mould, leaving the stuff full all round, and one side planed true. It will be found better to have two moulds for bevelling, one for each side of the piece, to supply the place of the line that will be lacking by reason of the piece being cut out square.

In Fig. 4 there are two moulds shown with the

piece between them, as it would be in practice for
bevelling. It is supposed to be placed with its
convex or outside edge downwards, and we are
looking at the concave or inside edge, the end or
centre joint c and the thin concave edges of the
moulds, the upper ends of which are shaded.

The lines A B and B C should be drawn on both
sides of the piece, to coincide with those on the
mould when the edges of both are even. Square c
across the centre joint, as shown by the dotted line,
and through the centre e of the thickness draw
the bevel c c, the same as found at 6 7 (Fig. 1).
From c c (bevelled line) draw another line on the
face of the piece parallel to B C. Slide the mould
on the top side upwards, so that the point c may
be moved from the square dotted line until it lays
over c c, the bevelled line, keeping A B on the
mould over its corresponding line on the piece.

Slide the mould on the under side in a similar
manner the reverse way, so that the point c may
be under the bevelled line c c. Fasten both
moulds to the piece with small screws, so that the
holes made by the screws may be taken out in
squaring the wreath. Take off the superfluous
stuff inside until a straight edge applied in a per-
pendicular direction will touch the edges of the
moulds all round. Take off the stuff outside
similarly, leaving it a little full.

Before taking the moulds off the piece, draw the line marked "springing" from the point where A G is squared across the edge of the mould. This line is made use of when jointing the wreath to the straight rail, and should always be perpendicular when the wreath is placed to its proper inclination.

Both wreaths being bevelled as above, the easing may be roughly made, that is, some of the super-fluous stuff may be taken off at top and bottom; or, in other words, the wreaths may be roughly squared, but should not be finished until the joints have all been made and bolted together. For the lower joint a bevel should be set with its stock to the under side of the straight rail (Fig. 2), and the blade made to coincide with the vertical or springing line, 1 A, or the hypothenuse and rise of the pitchboard. Then, in applying this bevel, hold the stock to the under side of the straight rail, and make the joint so that the spring-ing line on the wreath shall coincide with the edge of the blade.

The top joint is made in a similar way, and by using the bevel as directed, the springing line will be brought to its proper direction when the joint is bolted together. Or the pitchboard may be applied with the rise to the springing, and the line of the straight rail marked on the side of the wreath by the hypothenuse.

This way of obtaining the bevel will be found
to apply in every case with or without winders,
the stock being held to the under side of the
straight rail and the blade made to coincide with
the springing line on wreath.

To make the centre joint, a three-inch plank
should be used, one side planed true and the
edges shot square. The width should be equal
to the distance between the inside edges of the
rail in Fig. 1. Ascertain how much the rail
rises on the under side from 1 to 5 (Fig. 1), as
shown on Fig. 2. From the point where the
under side of the rail cuts the vertical line 1 A,
square over to the vertical line 5 ; then from this
point to that where the under side of the upper
rail cuts the same line will be the rise of the rail
on the springing from 1 to 5 (Fig. 1). Mark
this rise on the face of the plank. Take the first
wreath, and plane the joint square to the line B C
and face of the stuff. Handscrew this wreath to
one edge of the plank, making the springing line
to coincide with the face. Place the point where
the under side of the lower rail cuts the springing
to the bottom line on the plank. Then take the
top wreath and hold it to the opposite edge of the
plank. Keep the springing to the face, and fit
the joint until the point where the upper rail cuts
the springing is brought to the second line (or

the rise) on the plank.   This process may appear tedious, but in practice it gives very little trouble, while it insures perfect accuracy in the result.

This method of determining the rise of the rail on the springing line will be found to apply in every case.   In making the top and the bottom joints the centre of the rail is supposed to be placed to the centre of the wreath ; this, however, may be varied either way a little, so as to bring the rise or height correct.

To obtain the length of the rail, a rod about 2 inches wide should be used ; this should be laid edgewise on the nosing line of the flyers, or parallel to them, and the springing or vertical line marked on top and bottom.   Where a scroll is used, the face of second riser at bottom and springing at top should be marked on the rod. If we have a scroll and two or three commode steps, then the face of third or fourth riser, as the case may be, and springing.   Then this rod should be held to the under side of the rail when jointing up, and the springing lines on the wreath and those on the rod made to range in the same perpendicular direction.

It may perhaps be thought that we have entered somewhat too minutely into details for such a simple case as the above ; but we have

done so because the method of proceeding as here explained will be found to apply throughout in every case, except that a slight variation will be necessary for finding the centres in obtuse and acute angles; also where two or more commode steps are used, and when it is desirable to take in more than a quarter of a circle.

7. Perhaps it may help to render the study of the following Plates more interesting, and make them more easy of comprehension by the uninitiated, if we state that every mould according to this system will be found to belong to one of three classes.

The first and simplest is that represented on Plate II. All that is necessary to produce a mould of this class is to lay down the centre lines A B and B C at right angles to each other, and parallel to them C G and A G (Fig. 3). If then we mark off half the width on each side of A and C as directed, A G and C G at once give the direction and lengths of semi-diameters for drawing the curves of the mould.
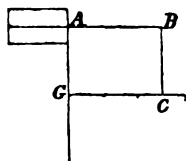
Fig. P.

The accompanying Fig. P is a facsimile of Fig. 3, Plate II., without the diagonal and curves. A B and B C are the centre lines, and A G and C G the diameters. The top mould

on Plate V. and the mould for scroll shank on Plate VII. also belong to this class.

An example of the second class, and almost as simple as the foregoing, is supplied by the bottom mould of Plate IV. This kind of rail will never present any difficulty. The diagonal A C is drawn first. Then A B and B C, and parallel to these A K and C K. Then the direction for the longer diameter will always be parallel to the diagonal A C through the centre K. Having obtained these lines, we next find the half widths, and lay them down on each side of A B and B C. This gives the points M, N, O, P, to which the curves of the mould should be drawn.

The annexed Fig. Q is a facsimile of Fig. 3, Plate IV., without the curves, A B and B C being the centre lines, A K and C K are parallel to them. K is the centre of the elliptic curve. The line parallel to - A C through K is the
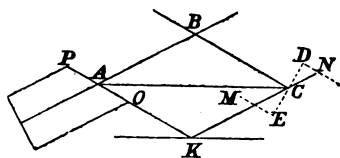
Fig. Q.

long diameter. M, N, O, P, are the points to which the ellipse should be drawn, and D E is the joint line. Figs. 3 on Plates IV. and V. belong to this class.

The third class is represented on Plate III.,

and this is the only kind of mould where the use
of the square is necessary for finding the direction
of the diameters. The same method is followed
as in the last example until the centre of the
curve is obtained. We then apply the square,
and find the direction as explained.

The accompanying Fig. R is a facsimile of
Fig. 3, Plate III., without the curves, &c. A C is
the diagonal, A B and B C
the centre lines ; N W
and S W are drawn paral-
lel to them. M, N, S, P,
are the points to which
the curve should be
drawn. W is the centre
of the ellipse, and D E the
direction of the longer
diameter. Fig. 4, Plate
IV., Fig. 3, Plate VI.,
and Fig. 3, Plate VIII.,
belong to this class.
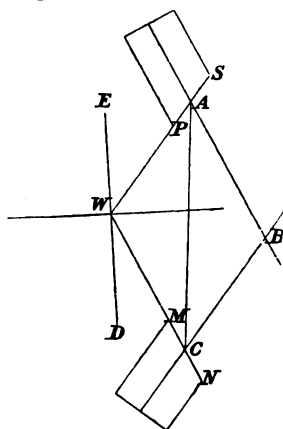
Fig. R.

It will be seen that the finding of the direction
of this major axis, or longer diameter of the
ellipse, is the same thing as finding the *oblique
plane, pitching plane,* or *plane of the plank* in other
systems of handrailing, and is done in a more easy
and less intricate manner. In other systems the
plan and mould figures have to be connected in a

particular way, so as to obtain the required pitch for the plank. In this system, on the contrary, each figure is separate and distinct, thus rendering them clearer and more easily understood. And if we have succeeded in making the use of the square for determining the direction of the diameters understood, no difficulty whatever should be experienced in describing the moulds.

PLATE III.

8. This Plate shows the method of getting out the mould for a handrail where there is a quarter-space of winders connecting straight flights.

Fig. 1 represents the plan of such an arrangement, and the whole width of the rail is laid down to the springing lines of the curve. In the quarter circle the centre only of the rail is drawn, and this is enclosed by the tangents 1 2 and 2 3.

Fig. 2 is the development, or stretch-out in elevation, of the centre line and the tangents of Fig. 1. Draw the vertical lines at the same distance from each other as the points 1, 2, 3 of Fig. 1; also the risers as they occur on the centre line, and the tangents of the plan, with the flyers above and below.

The pitches for the straight rail are drawn as previously described, the under side resting on the angles of the flyers, and the centre at the distance of half the thickness of the rail. Continue the centre of the upper rail in a straight line to

PLATE III.

Fig. 3.

Fig. 3ª.

top side

under side

Fig. 2.

rise

Fig. 1.

C
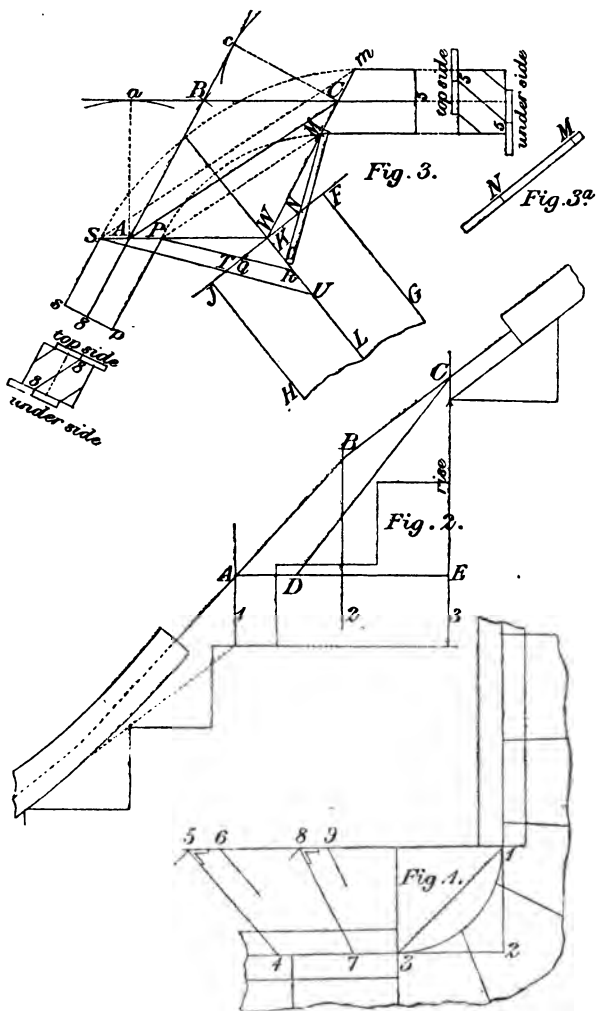
B, and from B continue it downwards to meet the centre of the lower rail, so as to form a fair easing on the same. In cutting out this easing, the stuff should be left full all round until the wreath is jointed to it.

The under side of the lower rail is prolonged to the vertical line 1 A. From the point where this line cuts 1 A square over to the springing, 3 C. Then from the point where this square line cuts 3 C to that at which the under side of the upper rail cuts the same line, will be the rise or height at which the wreath should be jointed to the lower rail.

The diagonal for the mould is obtained as before described. Thus from the point A, where the centre pitch cuts the springing, draw A E square to 1 A. From E set off E D equal to 1 3 (Fig. 1), and draw D C. Then D C will be the diagonal sought.

In order to get out the mould; we proceed as described before. Make A C (Fig. 3) equal to D C (Fig. 2). Take A B (Fig. 2) in the compasses as a radius, and with one foot at A (Fig. 3) draw an arc. Again, take as a radius B C (Fig. 2), and with one foot at C (Fig. 3), draw another arc cutting the former one at B. Draw A B and B C, and prolong them so as to make the distances A 8 and C 5, from A and C to the ends of t' mould, equal to the distances from A and C t'

joint in Fig. 2. Draw the end of the mould square to these lines. Through A and C draw A w and C w parallel to A B and B C. Then w will be the centre of the elliptic curves of the mould.

To find the bevel and width for the upper end of the mould, draw A *a* at right angles to B C, and with the distance A *a* as a radius, and the point 4 (Fig. 1) anywhere on the middle line of the rail as a centre, draw an arc cutting 1 5 at 5. Join 4, 5 ; then this will be the required bevel. Parallel to 4 5, set off half the width of the rail, and 5 6 will be half the width of the mould. Repeat this distance on each side of B C (Fig. 3), and draw parallel lines to cut the springing C w in the points M, *m*.

For finding the width of the lower end of the rail at A, draw C *c* at right angles to C w ; and with the distance C *c* as a radius, and any point 7 (Fig. 1) on the centre of the rail as a centre, draw an arc cutting 1 8 at the point 8. Join 7, 8 ; then this will be the required bevel. Parallel to 7 8, set off half the width of the rail, and 8 9 will be half the width of the mould. Repeat this distance on each side of A B (Fig. 3), and draw parallel lines to cut the springing A w in s and P. Otherwise, by drawing *m* s and M P parallel to A C, we find the points s and P on the

line A W. Then if we draw s s and P p parallel to
B A, we get the width of the rail.

This gives the points to which we have to
draw the curves of the mould, two for the
inner and two for the outer ellipse. The centre
w of these ellipses has already been found, and
the length of half the shorter diameters or
minor axes will be equal to the radii on plan
(Fig. 1).

From these we have now to determine the
direction and length of the longer diameters or
major axes.

Let F G H J be the square for this purpose (as
described in Plate I.), with K L at right angles to
J F. Place this square so that the point K at the
end of the line K L shall fall on the point w, the
centre of the ellipse, and that J F shall lie in the
supposed direction of its longer diameter. M and
P are the two points on the inner curve of the
rail through which the ellipse has to be drawn.
Now let M N and P Q be half the shorter diameter
(equal to radius for inside of rail on plan), and
prolong M N and P Q to cut K L in the points O and
R. Then if M O and P R are equal, J F will be the
direction of the greater diameter, and M O or P R
will be half the length of it. If at the first trial
M O and P R are not equal, we must move J F round
until they become so, always keeping the point K

to the centre w, and the points N and Q on the
edge J F of the square.

A thin straight edge, with the half shorter
diameter marked on one edge as shown at M N
(Fig. 3a), affords the most ready way of doing this.
Then M is placed alternately to the points M and
P, and N is made to lie on J F, which is placed so
that the continuation of the lines M N and P Q to
K L shall be equal.   J F then gives the direction
for drawing the longer diameter.   Or better still,
let an ordinary two-foot rule be held with the
edge to the points M and P, and the square so
placed that the distances of the point where the
rule cuts K L from M and P shall be equal, keeping
the points N and Q denoting the half shorter
diameter over J F.

To find half the longer diameter for the outside
curve, take the radius for the outside of the rail
on plan (Fig. 1) in the compasses, and placing
one foot at s (Fig. 3), draw an arc cutting the
longer axis at T.   Draw s T U, then s U will be
the half longer axis sought.

It should be observed that the direction of the
diameter once found answers for the inside, the
centre, and the outside of the mould.   It may
be found from any one of these three by em-
ploying the radius of plan corresponding to
whichever we may prefer using, which radius

will always be half the shorter axis for the elliptic curve.

Having found the direction of the axes, the process necessary to complete the mould is so simple as to need no further description.

The application of this mould to the plank for bevelling the wreath will be somewhat different to that on the preceding Plate, owing to there being two pitches and two bevels.

The piece is first cut out square to the shape of the mould, and the upper side planed true. The lines A B and B C are then drawn on the piece to coincide with those on the mould when the edges of both are even. Square these lines across each end, and through the centre of the thickness draw the bevels 5 5 and 8 8, the same as found at 5 and 8 (Fig. 1). Then from the points where the bevels across the ends cut the face, draw on the piece lines parallel to A B and B C.

The piece is now ready for bevelling, and for this purpose it is necessary to have two moulds. Place the mould on the upper side in such a position that A B and B C of the mould may be over, and in the same direction as the lines on the piece that are drawn parallel to A B and B C from the bevels across the ends.

The mould for the under side is applied in an exactly similar way, the lines of the mould being

placed over those on the piece that are drawn parallel to A B and B C, the difference being that one is moved upwards and the other downwards.

If this is clearly understood, there should be no difficulty in bevelling this or any other wreath. The ends of the piece are shown at Fig 3, with the square and bevelled lines drawn on. The ends of the moulds are also shown in the position they should occupy for bevelling the wreath.

Fasten the moulds to the piece and take off the superfluous stuff until a straight edge applied in a perpendicular direction will touch the edges of the moulds all round, leaving the stuff a little full on the outside. Before taking the moulds off, mark the springing across the inside edge, as on the preceding Plate.

In jointing this wreath to the lower rail with the easing, the centres of each are supposed to be placed opposite to each other. This, however, may be varied a little either way, so as to bring the height correct.

The bevel is obtained as before described (page 11), the stock being held to the under side of the straight rail and the blade made to coincide with the vertical or springing line 1 A (Fig. 2). Then in making the joint, hold the stock to the under

side of the straight rail, and fit the joint until the springing line on the wreath coincides with the edge of the blade.   The top joint is made in a similar manner and with the same bevel.

The easings here, as in every other case, on both wreath and rail may be roughly made, but should not be finished until the joints have been completed and the parts bolted together.

PLATE IV.

9. This plate shows the construction of wreaths for a quadrant of winders, a quarter-space or landing, and straight flights above and below.

Fig. 1 shows the plan of the well-hole, enclosing the half circle with the tangents 1, 2, 3, 4, 5. Fig. 2 is the development in elevation of Fig. 1, the distances from 1 to 2, from 2 to 3, and so on, being the same in both figures. The riser lines are set out in the development as they occur on the centre line and tangents of Fig. 1.

Draw the under side of the straight rail resting on the angles of the flyers, and at the distance of half the thickness of the rail set out the centre line. Continue the upper one in a straight direction to cut the vertical line 4 at D, and from this point draw the centre downwards to meet the lower centre, so as to form a fair easing on the straight rail. Draw the joints square to the pitches. Continue the under side of the lower straight rail to cut the vertical line 1, and from this point

PLATE IV.

Fig. 4.

Fig. 3.
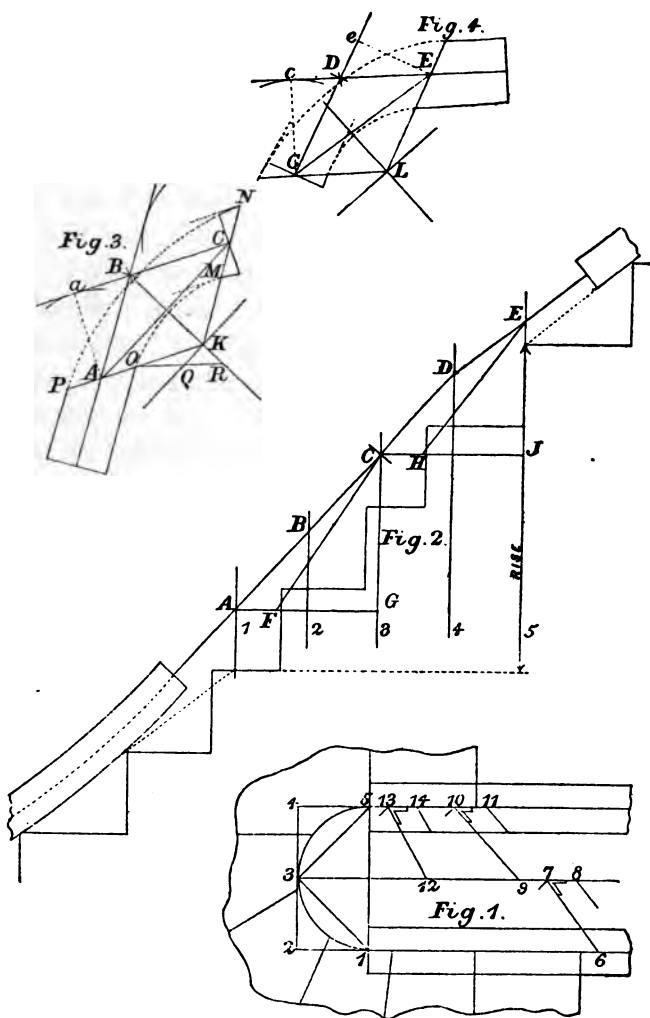
Fig. 2.

Fig. 1.

square over to the springing 5, thus obtaining
the rise or height to which the wreaths should
be jointed to the lower rail.

From A and c draw the horizontal lines A G and
C J. Set off from G and J, G F and J H, equal to
1 3 or 3 5 (Fig. 1). Draw F C and H E (Fig. 2) ;
these will be the diagonals for the moulds.

Fig. 3 shows the method of drawing the lower
mould. Make A C equal to F C (Fig. 2); then
take A B or B C (Fig. 2) in the compasses, and with
one foot at A and at C (Fig. 3), draw arcs cutting
each other at B. Draw A B and B C, and parallel
to them draw A K and C K. Then K is the centre of
the ellipse. Prolong A B, and make the distance
from A to the end of the mould equal to the
distance from A to the joint in Fig 2. Draw the
end of the mould square to A B.

Both pitches of this wreath being alike, only
one bevel is required. Draw A *a* at right angles
to B C, and with A *a* as a radius and the point 6
(Fig. 1) as centre, draw an arc cutting the centre
line at 7. Draw 6 7, and this gives the bevel.
Parallel to 6 7 set off half the width of the rail,
and 7 8 will be half the width of the mould.
Repeat the distance 7 8 on each side of A B (Fig.
3), and draw parallel lines to cut the springing
line A K in the points o and P. Also repeat the
same distance on each side of B C, and draw parallels

to cut C K in M and N. Then where these parallel
distances to B C cut C K, will be the points at this
end of the mould to which the elliptic curve should
be drawn.   M and N being these points, the out-
side elliptic curve will extend to N, while the
inside curve will not reach beyond M.   Thus
taking the length of the mould from O to M and
from P to N, it will be a quarter of an ellipse over
a quarter of a circle inside and out.   If this mould
(leaving the curves for the moment out of con-
sideration) were placed to its pitch over its plan
(Fig. 1), the four lines forming the rhombus would
lie over the four lines which on the plan form
the square.   A B would be over 1 2; B C over 2 3;
A K and C K over the two opposite sides; A C over
the diagonal 1 3; and if we were to draw the
quarter ellipse in the centre of the mould from A
to C, this quarter ellipse would lie over the quarter
circle 1 3.   Similarly the inside and outside
quarter ellipses extending from O to M and from
P to N would lie over the inside and outside
quarter circles of the rail plan; and if a vertical
joint were allowed, C K would be the joint line
for the mould, which is exactly similar to one
produced by the system of ordinates, the plank
having the same pitch.   But it is neither allowed
nor desirable, the butt joint being the more easily
made, and looking by far the best when executed.

The direction for the longer diameter in this and all similar cases will be parallel to A C through K, and the shorter axis at right angles to it in the line K B. This is owing to both pitches of the wreath being the same. The lengths of half the shorter diameters for both inside and outside curves will be equal to the radius for the inside and outside of the rail on plan. To find half the longer axis for the inside curve, take half the shorter one in the compasses, and with one foot at o draw an arc cutting the longer axis at Q. Through Q draw O Q R, meeting B K in R, and O R will be half the longer diameter sought. The major axis of the outer curve is found in the same way from P or N.

Now draw the quarter ellipses in the manner before described. Then draw the joint through C square to B C, and from the point where this joint line is cut by the convex curve, set off the whole width for this end of the mould towards the concave rather full, and continue the inside curve to this point, and the mould will be complete.

Fig. 4 shows the method of drawing the upper mould. C E is made equal to H E (Fig. 2), C D and D E are alike in both figures, and drawn as before. E L and C L are parallel to C D and D E. Then L is the centre of the elliptic curve. The distance

from E to the end of the mould is made equal to the distance from E to the joint (Fig. 2).

To find the bevel and width for the top end E, draw c c at right angles to D E, and with the distance c c as a radius and the point 9 (Fig. 1) as a centre, draw an arc cutting the centre of rail at 10. Draw 9 10, and this will be the required bevel. Parallel to 9 10, set off half the width of the rail, and 10 11 will be half the width of the mould. Repeat this distance on each side of D E (Fig. 4), and draw parallel lines as before.

For the lower end c, draw E e at right angles to D C, and with E e as a radius and the point 12 (Fig. 1) as a centre, draw an arc cutting the centre line of rail at 13; then the line 12 13 will be the bevel required. Parallel to it set off half the width of the rail, and 13 14 will be half the width of the mould. Repeat this distance on each side of C D (Fig. 4), and draw parallels to cut C L; then the points where these parallels to C D cut C L will be those, together with the points on E L, from which to find the direction and length of the diameter. These are obtained and the curves described as on Plate III. Draw the joint through c square to C D, and from the point where this line is cut by the convex curve, mark off the whole width towards the concave, and continue the inside curve to this point.

The remarks which we made as to the quarter ellipses of the lower mould apply also to this upper one. Thus, for a vertical joint, c l would be the joint line, and if this mould were placed to its pitch over the plan, the line c l would lie in the same direction as the centre line of the well-hole, with c perpendicularly over 3, and the two points in c l denoting the inside and outside of the mould, perpendicularly over the inside and outside of the rail on the joint line of the plan.

The moulds are exactly the same as if produced from ordinates, the plank of course having the same pitch; and anybody who understands how to get them out by ordinates, will know that they must be correct. It will perhaps be noticed that the piece added to the inside of the lower mould is greater than that added to the inside of the upper one. The cause of this is the difference in the pitch of the two wreaths, the top one being flatter than the bottom one. So in every case the sharper the pitch the greater becomes the piece to be added inside to make the joint a square butt joint, and *vice versâ*, until it happens that either of the lines A B or B C becomes level, as in Plates II., V., and VII., when there will be nothing to be added, and the joint line will always be at right angles to such level line, and also in the direction of the diameter of the ellipse.

10. Those who may wish to satisfy themselves further upon the above point, cannot do better than get two pieces of wood one inch square. This will be large enough to include the plan of the rail. On the sides 1 2 and 2 3 (Fig. 1) of the first piece, mark the pitches A B and B C (Fig. 2). Cut off to this bevel. On the sides 3 4 and 4 5 (Fig. 1) of the second, mark the pitches C D and D E (Fig. 2), and cut off to this bevel. Draw the line corresponding to tangent 2 3 and to B C of the mould on the bevelled end of the first piece; also the line corresponding to tangent 3 4 and C D of the mould on the bevelled end of the second piece. Then screw the two together, having the joint on the centre line of the well-hole, and keeping the end of the lines on the bevelled ends of the pieces corresponding to C of the moulds to the same height. On the square end of the two pieces thus screwed together, draw the half circular plan of the rail. Take off the stuff to these lines, leaving it concave on the inside and convex on the outside, corresponding to the inside

Fig. s.
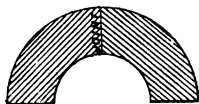
and outside of the rail on plan. The plan and elevation will then appear as in Figs. s and T, Fig. s being the plan, and Fig. T an elevation of the con-cave side. From this it will be evident, first,

that the quarter ellipse of the moulds must finish at the points we have indicated; secondly, that these points will always be perpendicularly over the inside and outside of the rail on the joint line of the plan; thirdly, that the triangular piece we added to the inside of the bottom mould belongs more properly to the top, and the piece we added to the inside of the top belongs more properly to the bottom; that is, if we divide the concave side of the rail plan into two equal parts, and from the point of division erect a perpendicular across the joint of the wreaths when together, each of the pieces we have added

Fig. T.
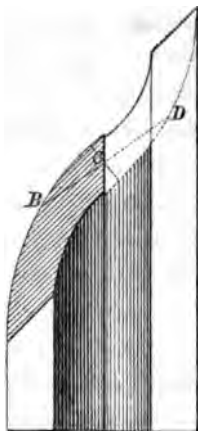
will be found to belong to and form part of the opposite quarter circle. The concave side of the mould, therefore, when the joint line is drawn, covers more than a quarter of a circle. But we cannot draw more than a quarter of an ellipse on the one mould when the other has a different pitch. We therefore draw the quarter ellipses first, then the joint line square to the tangent, and continue the inside curve to the joint line as directed.

It will be evident from these considerations that

to draw the joint square to the tangent, and to set
off half the width of the mould on this joint line
on each side of the tangent, will be incorrect. To
draw the curve of the ellipse with any accuracy
through points so obtained will be found im-
possible, especially when the wreath has a very
sharp pitch. The centre point will be right, but
that towards the convex side will be too far from
the centre, and that towards the concave will not
be far enough.

This will appear more plainly from an examin-
ation of Fig. u. Let the two semicircles represent
the plan of the rail. The
line dividing it into two A
quadrants and drawn to the
centre will be the joint line
of the plan, and A E will be

Fig. u.
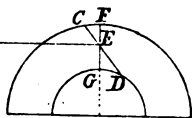
the tangent for the centre of the mould. When this
is placed to its pitch over the plan, the tangent of
the mould will lie in the same direction as A E, and
the centre will lie perpendicularly over E of the
plan.

But the joint line of the mould, instead of
being over the joint line of the plan, will be
more in the direction of C E D. (This may easily
be proved by drawing the joint through C square
to B C on the bevelled end of Fig. 3.) Suppose
we find the width of the mould here to be 5½

inches. If we set off $2\frac{3}{4}$ inches each side of the point perpendicularly over E, it will be evident that neither of the points so obtained will be perpendicularly over either outside or inside of the rail on plan. That towards the convex side will fall without the rail, and that towards the concave will fall within it. But instead of this, find the points perpendicularly over F and G. Draw the quarter ellipses to those points, and complete the mould as directed.

The application of these moulds to the plank, the jointing up and the bevel for same, will be similar in all respects to those described in the preceding Plates.

Make the easings, or square up the wreaths roughly, but do not finish them until the joints have been made and the parts bolted together.

PLATE V.

11. This Plate exhibits the moulds of a hand-rail for a half-space of winders, with a straight flight below, and the floor or landing at top.

Fig. 1 is the plan with the riser lines laid down as shown, and tangents drawn to the semicircular centre line of the handrail.

Fig. 2 is the development of Fig. 1 in elevation, the vertical lines 1, 2, 3, 4, 5, coinciding with the points 1, 2, 3, 4, 5, of the plan, and the riser lines drawn as they occur on the centre line of the rail, and the tangents to the semicircle.

The under side of the level rail at top is drawn at the distance of four inches from the floor, and the centre at the distance of half the thickness from the under side. This is continued in a straight direction, to cut the vertical line 4 in D. From D continue the centre downwards to meet the centre of the lower straight rail, so as to form a fair easing on the same. Mark the joints as shown, square to the falling line. The

PLATE V.

Fig. 4.

Fig. 3.

Fig. 2.
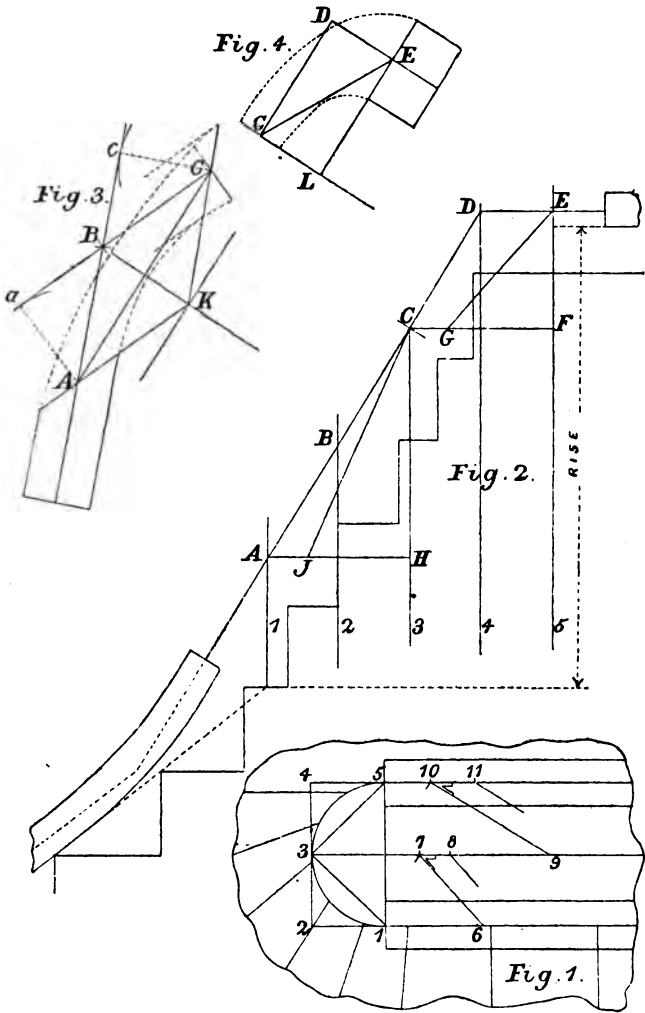
RISE

Fig. 1.

rise or height for jointing the wreaths to the lower rail is obtained as on the preceding Plates.

From A and C draw the horizontal lines A H and C F. From H and F set off the distance H J and F G, equal respectively to the diagonals, 1 3 and 3 5 (Fig. 1). Draw J C and G E. Then J C will be the diagonal for the lower mould, and G E the diagonal for the upper one.

Fig. 3 shows how to construct the lower mould. Make A C equal to J C (Fig. 2). Draw A B and B C as before, and draw parallel to them respectively A K and C K. Then K becomes the centre for the elliptic curves. Both pitches of this wreath being alike, the longer diameter will be parallel to A C, through the centre K, and the shorter one through K at right angles to the longer one.

From A to the end of the mould is made equal to the distance from A to the joint (Fig. 2). The bevel and width for each end is determined as before, by drawing A *a* at right angles to B C, and the distance A *a* is then applied as at 6 7 (Fig. 1) for the bevel, and half the width of the rail drawn parallel to 6 7, in order to obtain 7 8, which is half the width of the mould. These both apply to each end of the mould. The distance 7 8 is drawn on each side of, and parallel to, A B (Fig. 3), to cut the springing A K; and where the

D

same parallel distances to B C cut C K will be the points (together with those in A K) to which the quarter ellipses should be drawn.

Find the direction and length of the longer diameter, and draw the curves of the mould to those points as before. Then draw the joint square to B C, and from the point where this joint line is cut by the convex curve, mark off the whole width towards the concave side, and continue the inside curve to this point. The mould will then be completed.

Fig. 4 shows the method of constructing the upper mould. This presents no difficulty, the tangent D E being level. We proceed, however, by the same method as before, and make C E equal to G E (Fig. 2). We then draw C D and D E, and their parallels C L and E L, and L will be the centre of the curve. From L to C will be half the shorter diameter to the centre of this end of the mould (equal to radius for centre of rail on plan), and from L to E will be half the longer diameter to the centre of the top end.

To find the bevel and width for the top end, take L E or C D, and apply it from 9 to 10 (Fig. 1). This gives the bevel. Set off from 9 10 half the width of the rail, and 10 11 will be half the width of the mould. Draw parallel lines at this distance to D E (Fig. 4), to cut the springing line

L E. Make the distance from E to the end of the mould equal to the distance from E to the joint (Fig. 2).

The lower end requires no bevel. L C, being the shorter diameter, will be level, and the narrowest part of the mould is always on this diameter. The width here will therefore equal the width of the rail on plan. Set off half this width on each side of C on C L; then we have the distance from the centre L to the inside and outside of the mould on each diameter for drawing the curves.

When cutting this piece out of the plank the stuff should be left full at the narrow end.

Owing to the sharp pitch of this wreath, the mould produced at the top end has a great width, and if the piece were cut out to the full width of the mould, there would be more stuff used than necessary.

By the use of the bevel for this end the necessary width may be ascertained to a nicety. Thus, let A B C D (Fig. w) represent the top end of the piece, as it would be if cut out square to the full width of the mould E F G (7½ inches). Through the centre O of the width and thickness draw the bevel B D (the same as found at 9, 10, 11, Fig. 1, Plate V.). On each side of this line set off half the width of the rail, and draw the parallels

to B D. On the bevel line B D set off half the
thickness of the rail on each side of the centre o.
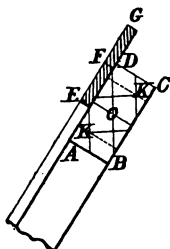
Fig. w.

Draw the top and bottom, and
through the angles K K draw the
dotted lines square to the face of
the piece.   Then these dotted
lines give the necessary width of
stuff to produce the wreath.
Thus, instead of 7½ inches,
only   5   inches   are   needed,
which is only one inch wider than
the rail. The mould, however, must be retained
the full width for bevelling the wreath, which is
done in the same way as any other of a similar
construction.

12. A word or two as to the lengths of balusters
that are necessary here, and on some of the other
Plates, may not be considered out of place.   Cer-
tainly the under sides of the wreaths are not drawn
so that the balusters on the winders may be the
same length as those on the flyers.   To have done
so would have spoiled the appearance and crip-
pled the falling line altogether, besides making
it more dangerous for persons using the stairs.

It is usual with some joiners to make an easing
on the upper straight rail as well as on the lower
one, and to make the under side of the wreaths
lie close to the narrow ends of the winders, so

that the rail may be the same height and the balusters have the same length as on the flyers. But this does not appear to us to be the safest plan, nor do we think that the rail always looks the best when executed in this way. It is not worth while to cripple the falling line of the wreaths and make them look very unsightly, as they sometimes do, for the sake of getting the balusters all the same length. It is better to execute the wreaths and easing so that the two combined shall have a good even-looking falling line, and to let the lengths of the balusters take care of themselves. These are, however, questions which every one must be left to settle for himself according to his taste and judgment. But we think the rail has a much better appearance when lifted over winders, especially if the ascent is sharp, as in small well-holes.

It will be noticed that in no single instance have we drawn an easing on the upper rail in any of the Plates described in these pages. Nor should we ever think of doing so unless compelled by circumstances which we could not control, or by superior authority.

This we believe to be the correct system, if one may be said to be more correct than another; and this we think will produce by far the best-looking handrail when finished.

But whichever way this question may be de-
cided, it will in no way interfere with the method
of getting out the moulds as taught here.   The
one thing necessary is to see that the centre fall-
ing line is leading in the same direction on each
side of the joint.

PLATE VI.

___

13. This Plate shows the construction of a mould for an obtuse angle, with winders and straight flights above and below. The general method of the preceding Plates is followed here in every particular, except in finding the centre for the elliptic curves of the mould.

Fig. 1 is the plan with the tangents 1, 2, 3 enclosing the circular centre of the rail. The radius lines 1 D and 3 D are drawn square to the straight rail from the centre D. The diagonal 1 3 is drawn between the two ends of the circular arc; D 2 will then be at right angles to the diagonal 1 3.

Fig. 2 represents the unfolding of the centre line of Fig. 1, the riser lines being placed as they occur on the centre, and the tangents. The vertical lines 1, 2, 3 of Fig. 2 will then coincide with the points 1, 2, 3 of Fig. 1.

Draw the falling lines of the rail as before, and continue the upper centre in a straight line down

to B, and from B downwards, so as to get a good easing on the lower straight rail.

From A draw the horizontal line A E, and from E set off E F, equal to the diagonal 1 3 (Fig. 1). Draw F C; then F C will be the diagonal for the mould.

Fig. 3 shows how to draw the mould. Make A C equal to F C (Fig. 2). Then draw A B and B C as before, extending each line as shown, and making the distances from A and C to the ends of the mould equal to the distances from A and C to the joints (Fig. 2). Draw the ends of the mould square to A B and B C.

To find the centre of the elliptic curve, bisect A C in G. From B draw B G. Take B G in the compasses, and with one foot at 2 (Fig. 1) draw the arc cutting the diagonal 1 3 at H. From 2 draw the line 2 H, extending it to meet the perpendicular on the line D 2 from D at J. Make B G D (Fig. 3) equal to 2 H J (Fig. 1). Then D will be the centre of the curve sought.

From D draw D A and D C through A and C. These will be the springing lines, and will denote on each outside edge of the mould the point where the straight and circular parts will meet.

The bevels and widths are obtained as on any of the foregoing Plates.

Thus, for the top end, draw A a at right angles

PLATE VI.

Fig.3.

Fig.2
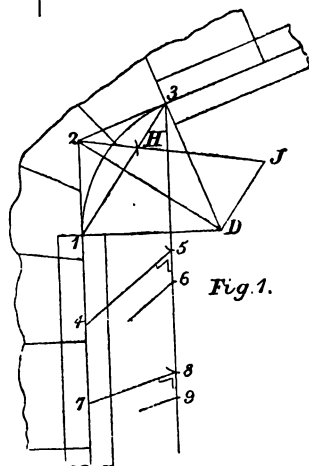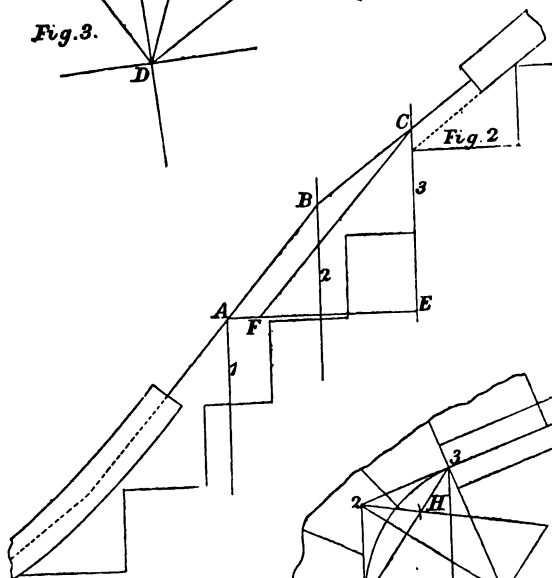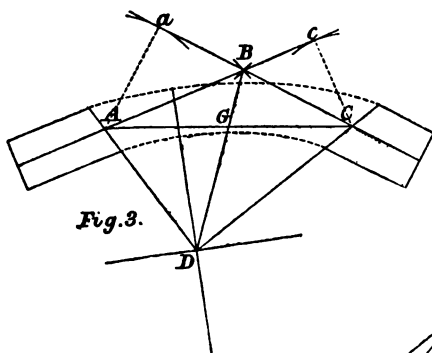
Fig.1.

to B C. Then, with the distance A *a* for radius, and the point 4 (Fig. 1) (anywhere on centre line of rail) for centre, draw the arc cutting the centre line at 5. Draw the line 4 5, and this will be the required bevel. Parallel to 4 5 set off half the width of the rail, and 5 6 will be half the width of the mould. Repeat this distance on each side of B C (Fig. 3), and draw parallel lines to cut the springing line D C.

For the bottom end the same method is followed, and the bevel and width, 7, 8, 9 (Fig. 1), obtained as above. This again is repeated on each side of A B (Fig. 3), and parallel lines drawn to cut the springing line A D.

Thus we have the two points in each edge of the mould, the centre D, and the length of half the shorter diameter, which will be equal to the radius of the plan for the inside and outside of the rail. From these we find the direction and length of the diameter, and draw the curves in the same way as on any of the foregoing Plates.

The application of this mould for the purpose of bevelling the wreath is the same as for a right-angled plan.

The method of proceeding with an acute angle (when the diagonals are at right angles to each other) will be the same as for an obtuse angle. The one Plate will therefore serve for the two angles.

PLATE VII.

14. This Plate shows the application of the author's method of handrailing to the production of moulds for scroll shanks. A very brief description only will be necessary, as the mould is drawn in a manner exactly similar to that used on Plate II.

Fig. 1 is the plan, having the centre of the largest quadrant of the scroll enclosed, with the tangents 1, 2, 3. The diagonal is drawn from 1 to 3, but it might be dispensed with in this and all similar cases, there being no difficulty in obtaining the angle B (Fig. 3), because it is a right angle.

Fig. 2 is the development or elevation on the centre line and tangents of Fig. 1, showing the top of scroll step and the next flyer. The under side of the rail is drawn resting on the angles of the flyers, and the centre line at the distance of half the thickness. Prolong the centre of the rail downwards, to cut the vertical line 2 at B.

PLATE VII.

Fig.1.

4 5
6
1
3 2

Fig. 2.

C
D B E A
1 2 3

C B
F A
Fig. 3.
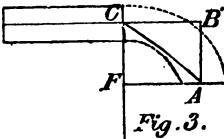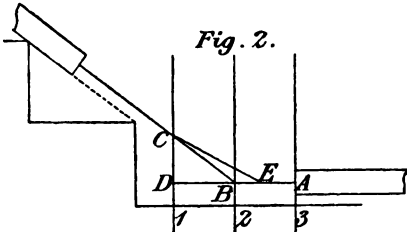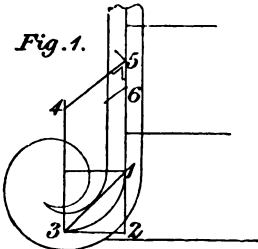
From B draw B A horizontal, and extend it to D. From D set off D E, equal to the diagonal 1 3 (Fig. 1). Draw E C, which will be the diagonal for the mould.

Fig. 3 shows how to draw the mould. Make the diagonal A C equal to E C (Fig. 2). Then take A B and B C (Fig. 2), and lay them down at Fig. 3, as before. Parallel to A B and B C draw C F and A F. The point F then becomes the centre of the quarter ellipses.

The only bevel we require here is one for the lower end. This is obtained by taking A F (Fig. 3) in the compasses, and applying it from 4 to 5 (Fig. 1). This will give the bevel. Parallel to 4 5, set off half the width of the rail, and 5 6 will be half the width of the mould. The top end will be square, and the same width as the rail on the plan. Set off the distances on each side of A and C, and draw the quarter ellipses of the mould as before.

The joint at 3 (Fig. 1) will be vertical, and may be made square from the under side of the level portion of the scroll, and square to the face and tangent A B of the wreath. It is better, however, to mark the springing on the inside edge of the wreath when it is bevelled, as in any other case. Then, in making the joint, place the level portion of the scroll on a level surface, and holding the

parts of the joint together, prove the springing
and the inside edge of the wreath with a set
square, both of which should be brought to a per-
pendicular position.

The upper joint presents no difficulty, the shank
end of the wreath being straight.   In making it,
however, the centre of the wreath should be placed
to the centre of the rail, except when it requires
raising or lowering to bring the height of the
newel right.   `

This method of drawing the mould in cases of
this kind might be dispensed with by using
ordinates and the pitchboard, which would give
the same bevel and pitch of plank.   If, however,
the tangent A B (Fig. 2) were drawn out of a
level, the pitchboard would not give the bevel
nor the pitch of the plank ; and the joint for the
level portion of the scroll, instead of being square
to the under side, would have to be bevelled.   So
that if by drawing A B horizontal the length of
the newel becomes too great, we have only to
decide what length it shall be, and draw the under
side of the scroll to suit this height.   Then at
the distance of half the thickness draw the centre,
and connect this with the point B, letting the
centre of the joint still be on the vertical line 3,
but taking care that the line from B to meet the
level centre shall be continued in a straight direc-

tion some little distance beyond the point A. This, perhaps, will be seen more clearly by referring to the following Plate, where we have been obliged to enter more minutely into the matter.

Fig. 2 unfolds in elevation the centre line and tangents of Fig. 1, the risers being placed in the development as they occur in the plan, on the centre line, and tangents. The distances 1 2 and 2 3 (Fig. 2) will then be equal to 1 2 and 2 3 (Fig. 1), with the flyers at top, the curtail step at bottom, and the diminished flyer between them.

Draw the under side of the straight rail resting on the flyers, and at half the thickness of the rail draw the centre line. Continue this in a straight direction, to cut the vertical line 2 at B.

In order to decide upon the height of the newel, suppose the top of the rail is to be 2 feet 8 inches in vertical height above the tread over the front of the flyer riser line. This rail will measure 4 inches in vertical thickness, and will therefore require lifting 2 feet 4 inches. If, therefore, the newel is to be 2 feet 6 inches, the under side of the level portion of the scroll will have to be drawn at a distance of 2 inches above the top of the curtail step. Draw the under side of the scroll at this distance, and the centre line at half the thickness of the rail. Then from B draw B A, to meet the centre of the level scroll some little distance beyond the vertical line 3 A. Draw the lower joint through A square to A B, and the upper one at any convenient distance from C. From A draw the horizontal line A E, and from E

set off E D equal to the diagonal 1 3 (Fig. 1). Draw
D C, which will be the diagonal for the mould.

Fig. 3 shows how to draw the mould.   Make
A C equal to D C (Fig. 2).   Then A B and B C (Fig. 3)
are respectively equal to A B and B C (Fig. 2), and
are drawn as before described.   A C, the diagonal
of the mould, is the line that will lie over the
diagonal 1 3 (Fig. 1) from end to end in an in-
clined position.   Take therefore A C (Fig. 3) in
the compasses, and with one foot at 3 (Fig. 1)
draw an arc at 5.   Then from 1 erect 1 5 perpen-
dicular to 1 3, cutting the arc at 5.   Draw 3 5,
and from 4 draw 4 6 parallel to 1 5 ; then 5 6
will be the distance from C (Fig. 3), through which
to draw B F.   Therefore make C F (Fig. 3) equal
to 5 6 (Fig. 1), and draw B F.   To find the
length of B G, take B F in the compasses, and with
one foot at 2 (Fig. 1) draw an arc cutting the
diagonal 1 3 at 7.   Draw 2 7 and extend it to 8,
where it cuts the line parallel to 1 3, drawn from
the centre of the largest quadrant of the scroll.
Then B G (Fig. 3) should be made equal to 2 8
(Fig. 1), and G will be the centre of the elliptic
curves.

The length B G may be determined on Fig. 1 at
either side of the point 4, whichever may be found
most convenient, as either will be correct.

This method of finding the length of B G is

necessary, owing to 2 4 not being square to 1 3 (Fig. 1), and it can be drawn square only when the centre of the largest quadrant of the scroll is in such a position as to admit of it. This of course will depend upon what direction the diagonal is drawn in. If it could be so drawn that a line at right angles to it from 2 would pass through the centre of the largest quadrant of the scroll, then the point F in A C (Fig. 3) would be in the middle of A C, and the length B G might be found in the same way as in the case of an obtuse or acute angle.

Having found the centre G of the ellipses, draw the lines A G and C G.

The bevels and widths are found according to the general method given above. Thus for the bottom end draw c c at right angles to A B (Fig. 3). Then at Fig. 1 extend the tangent 2 3 to 9, and from 1 draw 10 11 parallel to 2 3. Then, with the distance c c as a radius, and the point 9 for a centre, draw an arc cutting 1 10 at 10. Draw 9 10, and this will give the bevel. Parallel to 9 10 set off half the width of the rail, and 10 11 will be half the width of the mould. Repeat this distance on each side of A B (Fig. 3), and draw parallels to cut A G. For the top end, draw A a at right angles to B C (Fig. 3). Then from 3 (Fig. 1) draw 3 12 parallel to 1 2; and with A a

for a radius and the point 12 for a centre, draw
the arc cutting 2 1 produced at 13.   Draw 12
13, and this will be the bevel required.   Parallel
to 12 13 set off half the width of the rail, and
13 14 will be half the width of the mould.
Repeat this distance on each side of B C (Fig. 3),
and draw the parallel lines to cut the springing
line C G.

Thus we have two points in the inside curve,
the centre G, and half the shorter diameter of
the ellipse, which last will be equal to the radius
for the inside of the largest quadrant of the
scroll at Fig. 1.   From these we determine the
direction and length of the longer diameter,
and can draw the curves in the same manner
as before.   After describing the curves, draw
the joint at A square to A B, and the mould will
be completed.

We have drawn the lines at Fig. 1 for obtain-
ing the bevels beyond the scroll for the sake of
clearness.   This, however, is not necessary.
Having taken the distance at Fig. 3 for the top
end, one foot of the compasses may be placed
at 3 (Fig. 1), and the arc drawn to cut the line
1 2 in the same way as we have drawn it.   And
for the bottom end, with the distance taken at
Fig. 3 in the compasses, one foot may be placed
at 1 (Fig. 1), and the arc drawn to cut the

tangent 2 3. Either way will be correct, the one method producing the same bevel and width as the other.

This wreath is bevelled in exactly the same way as any other with two pitches.

The joint at the upper end may be made at any convenient distance from c, as before stated, and square to the face and inside edge. Let the centre of the wreath be placed to the centre of the rail, unless it should require slightly lowering or raising, in order to bring the under side of the level piece to the proper height of the newel.

For the lower joint, a bevel will have to be set with its stock to the under side of the level portion of the scroll, and the blade made to coincide with the joint line drawn through A.

The bottom end of the wreath may be planed square to the face, and to the tangent A B. It is much better, however, to make this lower joint as advised on Plate VII. Thus, plane the joint on the level portion of the scroll to its proper bevel and direction across the face. Then fix this level piece to a flat surface, and fit the lower end of the wreath until the springing line and inside edge are proved by a set square to be in a perpendicular position.

E

SQUARING THE WREATH.

16. As this perhaps has not been made suffi-
ciently clear in the foregoing pages, we will
endeavour to state the method we adopt as fully
and explicitly as possible.

Take such a pair of wreaths as those shown on
Plate II., where the straight rail has no easing.
Having bevelled them according to directions,
the easing may be roughly made as before de-
scribed. That is, some of the superfluous wood
may be taken off at top and bottom, or in other
words they may be roughly squared. But the
stuff should be left very full all round, as it is
difficult to tell where to take off and where to
leave on to a nicety with a single wreath until it
has been attached to the straight rail.

The joints being made as directed, take the
bottom wreath and bolt it to the rail. See that
the straight end of the inside, or concave edge, is
in a line with the edge of, and square to, the under
side of the rail. Clean off the outside edge of the
wreath to width of rail. Then take off the top
and bottom to a distance of 4 or 5 inches square
with the edge, and in a line with the top and
bottom of the rail. Go through the same

operations with the upper end of the top wreath
and rail. Then take them off the rail, and bolt
the parts of the centre joint together. See that
the springing lines are true, or out of winding
one with the other. Clean off the joint on the
concave side, so that the half circle may be seen
without any cripples by looking on the top.
Gauge to a width with a gauge like that shown
in Fig. z, slightly rounding the stem to fit the
concave side of the wreath, and letting the
distance from the stem to the pencil point be
equal to the width of rail. Then apply
the stem to the concave side in a per-
pendicular direction, and run the pencil
round the convex top and bottom of
the wreaths. Take the stuff off to
these lines, to bring them to the proper
width all round. Make the easing on
the top side by taking off the super-
fluous stuff between the two straight ends, so as
to produce an even-looking falling line, using a
square if it is thought necessary. Then gauge
to a thickness, and take off the stuff on the under
side, using a pair of callipers to see that the
proper thickness is maintained across the width,
as otherwise they are liable to be left thick in
the middle.

This will be found a safe and reliable method

Fig. z.

to adopt, either with a pair of wreaths or with
a single one.

Also when the lower rail has an easing the
same method will apply. And if the wreaths
have been jointed-up to their proper height, no
unsightly easings and mistakes are likely to
occur.

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